ISS-EWATUS

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no [619228]

Project Full Title:	**Integrated Support System for Efficient Water Usage and Resources Management**
Project Acronym:	**ISS-EWATUS**
Grant Agreement:	**619228**
Project Duration:	**36 months (Feb. 2014 – Jan. 2017)**

ICT - Information and Communication Technologies

D3.3 Field Study Report and User Manual of DSS

Deliverable Status:	**Final**
Due Date:	**31 January 2017 (M36)**
Submission Date:	**April 2017**
Dissemination Level:	**Public**
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History

Version	Author	Date	Status
1.0	Kim Perren	31st August 2016	Initial Draft
1.1	Lili Yang	20 January 2017	Second Draft
2.0	Shuang-Hua Yang	23 March 2017	Third Draft
3.0	Kostas Kokkinos, Chrysi Laspidou, Łukasz Kurcius, Wojciech Froelich, Rafał Ulańczyk	02 April 2017	Fourth Draft
4.0	Shuang-Hua Yang	5 April 2017	Fifth Draft
5.0	Shuang-Hua Yang	17 April 2017	Final

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1.Introduction

This report presents fieldwork conducted for the 'Decision support system for the efficient water usage at households' (household DSS) module of the Integrated Support System for Efficient Water Usage and Resources (ISS-EWATUS) project. Household DSS user manuals are appended as annexes. As described in the ISS-EWATUS Description of Work (DoW) the household DSS module is a part of a larger modular system for promoting the efficient use of water across numerous domains. In the DoW, two products are associated with the household DSS.

"At household level: an information system for gathering data about water usage is planned to increase the awareness of water consumption; the data will be interpreted and presented to household consumers in an understandable way using mobile devices (smartphones, tablets). A household decision support system (DSS) will be developed for mobile devices to reduce water consumption. Recommendations regarding water-saving devices and behaviour will be produced." (Page 3; Part A of the DoW)

As specified in the DoW, individual modules of the overarching ISS-EWATUS system were to be validated at two locations which are disparate in terms of culture and climate. This was established to ensure that the solutions produced could be implemented at any European Union location. The household DSS, and its allied data collection system, were to be validated in volunteer homes in the cities of Sosnowiec, Poland and Skiathos, Greece.

1.1 Fieldwork components

In the ISS-EWATUS Description of Work (DoW) two work packages addressed the implementation of the household DSS app and the allied information gathering system in pilot households. A team at Loughborough University (LU) was the designated leader for both work packages and so was responsible for fieldwork design. Sosnowiec fieldwork was conducted by the Institute for Ecology of Industrial areas (IETU) in nearby Katowice; they were supported by Sosnowiec's water authority, RPWiK. Skiathos fieldwork was conducted by the Centre for Research and Technology, Hellas (CERTH) based in Thessaloniki with the support of Skiathos water authority DEYASK. CERTH is based in Thessaloniki which is located on the Greek mainland, 300 kilometres from the island of Skiathos. The fieldwork ramifications of this considerable distance are considered in this report.

In Work Package 2 (WP2) Loughborough University was tasked with designing and developing a low cost water consumption monitoring system. Following laboratory-based verification of the system's components this was to be installed in up to 40 homes; 20 in Sosnowiec, Poland and 20 in Skiathos, Greece, by the end of the first year of the project (month 12). This monitoring system would be in place for 24 months. Fieldwork components were specified in Task 2.2 of the DoW "Design and installation of water consumption sensors at households".

The following fieldwork-related steps were identified:

- Call for voluntary households to participate in the research work including preparing call-for-participant leaflets, interviewing of the candidates, and visiting households.
- Identify the technical requirements of the water consumption monitoring systems, including locating the possible spots for water flow-rate sensors, the layout of the monitoring system, and the sizing of the same system.
- Check the Internet connection at households, if necessary, a new enhanced broadband access will be provided.

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- Carry out a single household test, i.e. choosing one household and testing the monitoring system installed in the household.
- Install and test the water consumption systems at the households.

In Work Package 3 (WP3) Loughborough University was tasked with designing and developing an app-hosted household decision support system. This would provide residents of monitored homes with bespoke feedback about their water usage as well as advice on ways to conserve water. The system was to be made available to residents of monitored homes at the end of the second year of the project (month 24). Feedback and advice was to be provided for up to 12 months. Task 3.4 "Implementation and maintenance of the DSS at household level" includes two steps that relate to fieldwork, namely, "carry out field trial of the DSS" and "deploy the DSS in all the pilot households." (Page 12 DoW).

1.2 Report structure

One component of the ISS-EWATUS project entails the development of a mobile application- (app-) based household decision support system (household DSS). The current document reports on the implementation and maintenance of this household DSS and the provision of user manuals.

As the report marks the end of this three year project, Chapter 2 contextualizes this phase by providing a brief overview of the rationale for the household DSS. The rest part of the report is organised chronologically. Section 3 outlines how volunteers were recruited to the study; it also describes the procedures implemented to encourage volunteers to continue to engage with the study across its lifetime. Section 4 presents fieldwork associated with the installation of domestic water monitoring equipment and subsequent in-home maintenance. Section 5 addresses the fieldwork associated with installation of the household DSS app. Section 6 describes the implementation and the maintenance of the DSS. End user feedback is reported in Section 7. English, Greek and Polish versions of the user manual are presented in sections 8,9 and 10 respectively.

2. Overview of the rationale for the household DSS.

The ISS-EWATUS DoW specified that a water consumption monitoring system would be developed to collect household data. A household DSS would be developed to provide residents with feedback on their household's water consumption and advice on how to conserve water. It was theorized that the presence of the household DSS in monitored homes would lead to a sustained reduction in water consumption. To test the efficacy of the household DSS, water consumption would be monitored in volunteer (pilot) homes for up to 24 months. Midway through this period, the household DSS would be implemented. Consumption data collected prior to the implementation of the household DSS would provide a baseline for evaluating the impact of the household DSS on household water consumption.

The household DSS app was conceived as a persuasive technology; consequently, its design would incorporate a range of strategies for helping or persuading consumers to reduce their water consumption. In light of this intention, its design was to be informed by behaviour change theory and extant empirical literature as well as analysis of primary data collected through a series of quantitative and qualitative social scientific field studies. Analysis of data collected by the water consumption

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monitoring system would yield insight into the water-related practices of pilot households. These insights would inform the design of the household DSS and permit the provision of 'smart' tips, that is, water conservation advice tailored to the practices of the individual household.

The current deliverable reports on the implementation and maintenance of the household DSS in real-life conditions as well as the production of user manuals. Eight other tasks are closely associated with the development, operationalization and evaluation of the household DSS. For clarification, Table 1 sets out all nine tasks, their scheduled end date (in terms of project months) and the associated project report (i.e. deliverable).

Table 1: Tasks related to household DSS and associated project report

Task	Task title	End month	Report number	Report title
2.2	Design and installation of water consumption sensors at households	12	D2.2	The installation of sensors at household level
2.4	Field studies such as interviews and questionnaires, house visits	8	D2.3	Study of the results of questionnaire and content of the database data
2.5	Design and implementation of databases	12		
2.6	Maintenance of [water consumption monitoring] data gathering	36	D3.3	No deliverable specified
3.1	Developing a water consumption data model	12	D3.1	Data and practice model of water consumption at household level
3.2	Developing a water consumption practice model	18		
3.3	Intervention strategies design	24	D3.2	DSS at household level
3.4	**Implementation and maintenance of the DSS at household level**	**36**	**D3.3**	**Field study report and user manual of DSS**
3.5	Analysis of the outcomes obtained from the DSS at household level	36	D7.2	Report of the validation and evaluation

3. Recruitment of pilot households

The intervention seeks to establish whether the household DSS app facilitates water saving among motivated residential water consumers. This shaped the criteria used to select households for monitoring. The DoW lists the following selection criteria: computer savvy, Internet connection, strong interest in water saving practices and willingness to modify habits for urban water system sustainability. Engagement with digital technology is relatively low in both Poland and Greece. In 2013, around 32 per cent of Polish adults and 35 per cent of Greek adults owned a smartphone; adoption of this technology was associated with higher levels of education (Mobile Planet 2013). As a consequence of this selection process, adult residents of monitored households are predominantly highly educated. The initial plan involved the installation of water consumption monitoring systems in ten households in Sosnowiec and ten in Skiathos. However, reviewers of the proposal suggested increasing this; consequently, water consumption monitoring systems were installed in 20 homes in each location. More information is contained in D2.2.

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3.1 Advertising study

For Sosnowiec, residents of a single apartment block were targeted as potential pilot households. Consequently, layout of the property, and potential sensor sites, could be established prior to volunteer household selection. Meetings were conducted to provide information to potential volunteers.

For the Skiathos site, multiple modes were utilized to advertise the study to a wide audience of potential volunteers. Call-for-participant leaflets were printed and distributed. Meetings were conducted to provide additional information.

3.2 Household selection

Household selection entailed interviewing people who put themselves forward for the study. For shortlisted candidates, home visits were conducted to establish the suitability of the property in terms of layout and Internet connection. Potential sites were identified for water flow sensors. An agreement has been signed by each household before the installation is started. The household socio-demographic details are various in terms of age, family size, household income and working persons in the family. Tables 2 and 3 below give details of the volunteer households in Sosnowiec and Skiathos respectively. Only the ten households equipped with LU wireless devices are given in Table 2, the rest ten households equipped with the Apator monitoring systems are omitted here as it does show the detail of the appliances. One household in Skiathos withdrew from the study and is omitted in Table 3. All the volunteers are encouraged to continue to engage with the study across its lifetime. The Internet access and a smart tablet have. been promised to all the participating families.

Table 2: Details of volunteer households in Sosnowiec equipped with LU wireless devices only.

Household ID	Family members	Members age	Education (adults)	Working persons	Household income PLN
1	1	60	Vocational school	1	1000-2000
2	4	38,38,10,7	University, University	2	2000-4000
3	4	37,34,6,3	University, University	2	6000-8000
4	4	47,44,13,11	University, University	2	>8000
5	3	42,39,11	University, Highschool	2	2000-4000
6	1	30	University	1	2000-3000
7	1	35	University	1	3000-4000
8	4	36,34,10,6	University, University	2	2000-4000
9	4	42,40,16,11	University, University	2	3000-4000
10	4	40,40,7,5	University, University	2	2000-4000

Table 3: Details of volunteer households in Skiathos.

Household ID	Family members	Members age	Education (adults)	Household income PLN
1	5	53, 50, 21, 18, 17	Primary school, High school, High school,High school,High school	50,000

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2	4 (+6 persons during summer)	44,48,24,21	High school, High school, High school, High school	40,000
3	4	47,46,13,11	High school, High school, Primary school, Primary school	15,000
4	3			
5	4	50,47,18,15	High school, University, High school, High school	70,000
6	4	44,15,12,17	High school, High school, High school, High school	15,000
7	4	50,50,14,14	High school, High school, High school, High school	50,000
8	4	43,41,10,7	University, University, Primary school, Primary school	20,000
9	4	50,47,16,14	PhD, MSc, highschool, highschool	35,000
10	4	42, 36, 3, 6	University, High school, Kinder garden, Primary school	25,000
11	4	49, 45, 25, 19	High school, High school, High school, High school	35,000
12	5	80, 47,42, 12, 9	High school, High school, High school, Primary school, Primary school	100,000
13	5	53,45,14,13,9	High school, Primary school, High school, High school, Primary school	100,000
14	3	40,39,2	Primary school, High school, Kinder garden	20,000
15	3	58, 49, 14	High school, High school, High school	30,000
16	4	38,38,5,4	University, University, Kinder garden, Kinder garden	100,000
17	4	60,35,34,38	High school, University, University, University	80,000
18	3	48, 15,14	University, High school, High school	30,000
19	4	46,45,15,12	High school, University, High school, Primary school	27,000
20	Withdraw from the study and ignored here.			

4 Installation of water consumption monitoring system

The water consumption monitoring system developed for the ISS-EWATUS project is a wireless data gathering and information system. Sensors are attached to water appliances around the home such as washing machine, kitchen taps, shower and toilet. The home WiFi system sends data collected by these sensors to a remote server which records the water flow rate and water temperature associated with each appliance. Details of the water consumption monitoring system architecture are included in deliverable D3.2, Chapter 4, and are simplified here.

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Figure 1. Architecture of the water consumption monitoring system

For the Polish site, two kinds of water monitoring system are used. Both monitoring systems transmit data in near real time to the ISS-EWATUS spatio-temporal database to make them available for further processing and use in the household DSS app. The first system was designed by Loughborough University (LU monitoring system) and has been funded through the ISS-EATUS project. The second relies upon commercially available smart water meters supplied by the Apator Company (Apator monitoring system). The Apator monitoring system is based on flow meters and gathered data need to be post processed before being made available to consumers via the household DSS. The rationale for using two systems was to ensure that the household DSS is not limited to one type of water consumption monitoring system. The LU monitoring system provides more accurate data of higher temporal resolution and enables household DSS users to see their water consumption data in near-real time. This system is, however, more vulnerable to damage as it is installed on pipe connections. The Apator system provides less accurate data and there is delay in providing feedback on consumption. In addition, installation involves the cutting of pipes in walls. However, when the system is installed, there is a negligible risk of damage.

Ten homes in Sosnowiec are equipped with LU household monitoring systems. In total, 44 sensors have been installed. Ten homes have been fitted with the Apator monitoring system; 77 sensors were utilized. Appliances monitored in this way include: kitchen taps (hot and cold), dishwasher, bathroom taps (hot and cold), toilet, shower and washing machine. At the Greek demonstration site, Skiathos, 20 households were equipped with the LU monitoring system. In total 46 sensors have been installed. Further details on both monitoring systems can be found in ISS-EWATUS Deliverable 2.2, Chapter 2. Figure 2 shows the places of the sensors in households. There are many restraints of the implementation of wireless devices, for example toilets and shower room are wet and not safe to install any electrical devices including our wireless sensor nodes. Many flat ends with a single sensor in water sink at kitchens. This causes the difficulty to measure the total water consumption for the household but not affect the intervention to household's water consumption behavior through DSS. Figure 3 illustrates the implementation of an Apator monitoring system. It gave the total water consumption for each household.

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Figure 2: Implementation of the wireless sensors and gateways at households.

Figure 3: Apator monitoring system installed inside a wall

5.External functions designed in the household DSS

Functions provided by the household DSS app may be viewed as autonomic; that is to say, they incorporate sophisticated automated processes which require minimal manual data input from the user. Explicitly, the household DSS is conceptualised as persuasive technology rather than information technology.

From a behavioural intervention perspective, one problematic issue with the autonomic functions of the DSS app is that they cannot differentiate between the actions of different household members. In effect, 'personalized' feedback on water use is not truly personal. A family may comprise a mix of careful and wasteful water consumers but all are presented with the same water consumption feedback. In this situation, the advice generated using household data may be irrelevant to the practices

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of that individual. This lack of clarity about individual consumption may limit a household member's appreciation of their own water using behaviour which may have repercussions for their motivation to change. Furthermore, individuals may not be provided with the accurate information they need in order to take control of their water consumption. In order to compensate this drawback, an external function "Waterdiary" was implemented in the DSS to identify individual water consumption behaviour. The detail has been given in the user manual in the appendix.

An additional issue with autonomic functions of the household DSS app is the lack of information about the consumer's attitudes, most saliently in the domain of the environment. This limits the DSS's capacity to utilize two of the most powerful behaviour change strategies; exposing subjective norms and invoking cognitive dissonance. Cognitive dissonance theory states that people want their views about the world to be consistent. Inconsistency (dissonance) makes them uncomfortable and they seek to reduce it. Subjective norm theory proposes that individuals who are made aware that their behaviour is judged unfavourably by significant others will feel an internalized pressure to conform. In addition to the role played by the water conservation social media site, an external app was developed which sought to address these shortcomings, which is called "Water user classification". The detail has been given in the user manual in the appendix.

6. Implementation and maintenance of the household DSS

An app mounted on a tablet computer provides feedback on the household's water use in near-real time, broken down by appliance. It also offers 'tips', i.e. water-related information and advice. A remote database contains a wide variety of tips; the system selects appropriate tips for the user on the basis of analysis of the household's recorded water usage. Users may view their household's water consumption, broken down by appliance, across the past 24 hours or at a daily, weekly or monthly level. They can set themselves a target for reducing their overall water consumption and the app will give them feedback on their progress towards this goal. A News function provides personalized information (tips) on saving water around the home. Personalised tips are generated in response to the household's recent, as well as predicted, water consumption. A water diary function is provided to encourage households to come together and identify the water consumption associated with individual household members. An additional function uses information on a user's showering and laundry habits, and household appliance efficiency, to highlight where a consumer's water use practices do not align with their level of environmental concern. The household DSS also provides a link to a social media website which aims to bring together water consumers and water experts. A detailed account of these functions is contained in Deliverable D3.2, Chapter 5.

The functions incorporated into the household DSS embodied intervention strategies such as: normative influence, inconsistency, control, self-monitoring, personalization and ambient display. The choice of strategies was informed by theorized drivers of residential water use behaviour (see D3.2, Chapter 3). These drivers had been identified by data, practice and intervention models constructed by the project team. These in turn derived from a literature review of behavioural theory and prior empirical research as well as primary fieldwork conducted in and around the pilot sites of Sosnowiec, Poland and Skiathos, Greece (D2.2, Chapter 2; D3.1, Chapter 2 and; D3.2, Chapter 3).

The current deliverable reports on completion of Task 3.4: Implementation and maintenance of the DSS at household level. The task is described in the DoW as follows:

> "The work task will design and implement a DSS for water consumption reduction at the household level. The developed DSS will be based on mobile devices, such as smart phones or other tablets, connected to a central database. The DSS aims to provide the householder a good

awareness of water consumption in a meaningful and effective presentation. The data model, practice model and intervention model produced in the previous tasks within this WP will be embedded in the DSS, particularly taking into consideration the user's attitude towards changing or maintaining their behaviour. The existing persuasive technologies such as tailoring, tunnelling, reduction and social comparison will be used to implement the paths for persuasion."

Task 3.4 spanned months 12 to 36 of the project: consequently, some steps have been reported in a previous deliverable, "D3.2: "Decision Support System at Household Level". Table 4 lists the steps specified in completion of Task 3.4 and identifies the relevant deliverable.

Table 4: Steps associated with Task 3.4

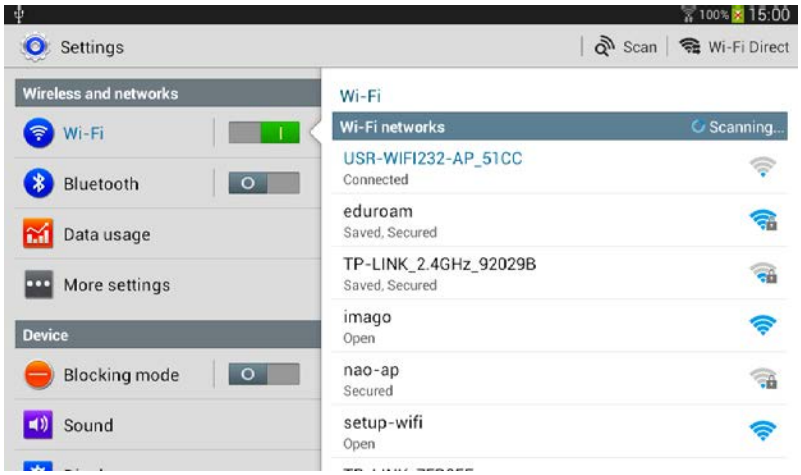
Step	Deliverable
Specify the functionality of Decision Support System	D3.2 Decision Support System at Household Level
Design the architecture based on the available hardware platform at the household level	
Implement the DSS which should be based on mobile devices platform, particularly tablets, and realise data model, practice model and intervention model, and with the support from a central database located at the remote server	
Carry out lab testing of the DSS	
Deploy intervention strategies obtained in Task 3.3 at the pilot households	Current
Carry out field trial of the DSS	
Deploy the DSS in all the pilot households	

Implementation of the household DSS includes the following three steps:

Step 1: download the DSS software into a tablet. From the DSS web page http://212.106.179.154/DSSabout click DSS_Tablet. The app will download automatically. The app name will start with ISS-EWATUS. When download is complete, install by clicking on the app and then clicking 'install'. When installation is complete, click 'Open' to access the app.

Step 2: configuration of the mobile device

The device that will host the app must be linked to the DSS Gateway Wi-Fi network. The 'Settings' app on the device lists available Wi-Fi networks. Click on the network with the prefix 'USR' and click 'connect' to join the DSS network. By default, there is no password. If a password is required, consult the system installer.



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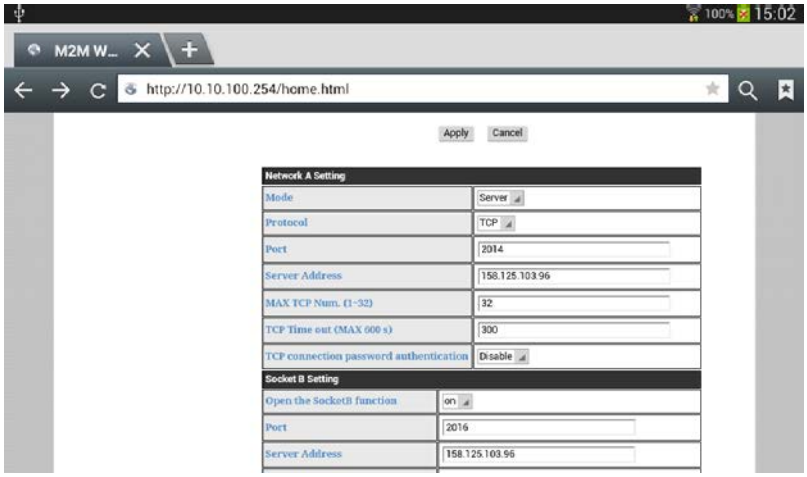
Check the connection by using the tablet's Internet browser to access the DSS gateway at http://10.10.100.254/. Click on the 'Application Setting' tab, scroll down to the Network A setting and ensure that its port is set to 2014.



Step 3: Configure the tablet.
When the DSS app starts for the first time, it must be configured so that it displays the correct information for the individual household. Go to the Configuration page (below).

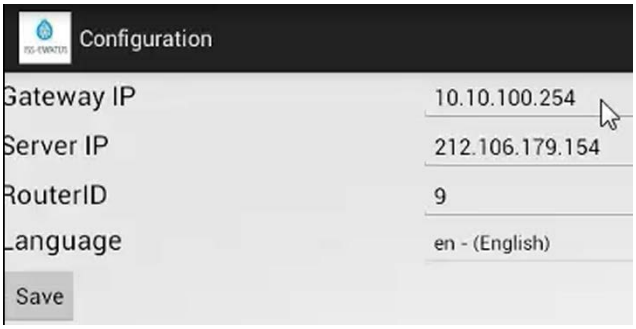


Figure 4: DSS configuration

Do not change the Gateway IP. The Server IP should end in 154 for Poland and 153 for Greece. Set the router id, which can be found on the back of the gateway. Remove the front 0x and initial 0. If the preferred language is not English, change the language accordingly. Click 'Save' when configuration is complete. The DSS system is now ready to be used.

Step 4: pass the tablets to the households and show them how to use the DSS.

No household reported any problem about the DSS installed in their tablet. Unfortunately the maintenance of the water consumption monitoring system has involved significant manforce even the fault detection was conducted automatically in remote side. Figure 5 shows the web portal of the maintenance of the wireless monitoring system. In the most cases the fault came from the link between the tablet and the wireless gateway as the tablet has been forced to connect with a different wireless system rather than the wireless gateway of the water consumption monitoring system.

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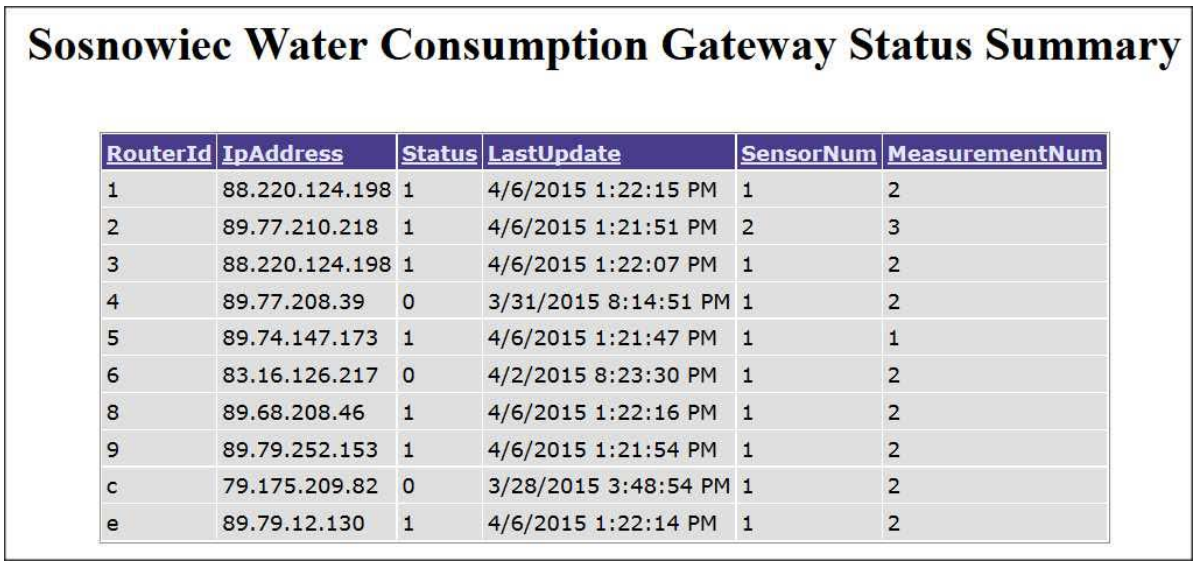

Sosnowiec Water Consumption Gateway Status Summary

RouterId	IpAddress	Status	LastUpdate	SensorNum	MeasurementNum
1	88.220.124.198	1	4/6/2015 1:22:15 PM	1	2
2	89.77.210.218	1	4/6/2015 1:21:51 PM	2	3
3	88.220.124.198	1	4/6/2015 1:22:07 PM	1	2
4	89.77.208.39	0	3/31/2015 8:14:51 PM	1	2
5	89.74.147.173	1	4/6/2015 1:21:47 PM	1	1
6	83.16.126.217	0	4/2/2015 8:23:30 PM	1	2
8	89.68.208.46	1	4/6/2015 1:22:16 PM	1	2
9	89.79.252.153	1	4/6/2015 1:21:54 PM	1	2
c	79.175.209.82	0	3/28/2015 3:48:54 PM	1	2
e	89.79.12.130	1	4/6/2015 1:22:14 PM	1	2

Figure 5: Web portal of the maintenance of the water consumption monitoring system in Sosnowiec

7. End User Feedback

7.1 In Skiathos, Greece

The positive attitude of the residents who participated in the pilot study of household water consumption monitoring system was from the beginning of the project. Almost all residents participating are part of multi-member families (on average 3-4 members) and the same social characteristics (positive attitude in using the system) have recognized by all of them. Initially all participants were willing to install the monitoring systems at their houses.

Apart from the fact that some of the installations at the beginning had major difficulties (electricity plug-ins away from the data loggers, considerable distance of the sensors installed and the gateway, setting problems with the configuration of the gateways), residents in general spent the time to understand the basic functionality of the system and had asked important questions to make sure that the monitoring system would keep working even in extreme situations. In the middle of the study residents formed focus groups and actively participated in the research methodologies chosen by the LU partner in order to extract the social characteristics from each group that affect the daily water consumption in households and to realize what are the major factors that make residents overspend water. In these focus groups residents participated not only via surveys but also answering general and later on specific questionnaires which were the primary source of all the statistical results extracted in this study.

Furthermore, when residents were given the tablet promotion gift that came with the household DSS and the Water Diary App, initially had few problems in working with the two applications. Soon enough some of the occurred problems stopped due to the easy user interface of the two programs. Most of the time residents have operated the programs (especially the water diary app) according to the rules and succeeded to produce valuable results which were casted and stored in the spatiotemporal database of the whole system. Participation and results taken have been discussed previously.

Overall, the residents of Skiathos were happy to participate in this study. They said that they have learned a lot about the ICT and the systems installed have caused for them to start saving water by realizing that major daily household functionalities and operations can still be performed however by spending less water than usual. As to daily personal operations (taking showers and baths), the same

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people have agreed that previously were suing the water without thinking the unnecessary spending but now, realize that water saving is possible, is good for the environment and helps reducing the water bills every trimester.

7.2 In Sosnowiec, Poland

Searching of households for the purpose of testing and validation of the ISS-EWAYUS decision support system took more than two months. Initially, people did not respond as enthusiastically to the call for volunteers as it was anticipated by the project team. However, the attitude was changed totally after the clarification of 1) the purpose of monitoring (collecting data for the international research project) and 2) aims of the ISS-EWATUS project. Households were selected in a way ensuring the significant diversity. Therefore, in the project participated: older people (60+), young single and young couples, and mostly families with one or two children. Households were apartments varying from approx. 30 to 100 square meters what is typical for the city of Sosnowiec. Also the income of families was diversified ranging from 50% to 200% of the average national income.

All selected households were equipped with tablets and participated actively in the testing of DSS, and in the validation. Participation of households resulted in the collection of 23-months records of the water consumption and half of households provided information about 100% of water consumption in this nearly two years period. Since the water diary application was added to the DSS, households have answered more than 1200 times the question about the purpose of water use and about the person who had used the water at given time.

Households have participated in two questionnaire surveys and part of them also in two focus groups' meetings, organised in the middle of the monitoring campaigns. Similarly to the Greek case study, participants not only answered all questions but took part in discussions and asked questions related to the project and generally water saving issues (about the environmental impacts of water consumption / pollution and about the ICT solution aimed at the water saving).

Apart from the planned activities, there were several interventions required in order to keep the monitoring systems fully operating. Such interventions were occurring as a consequence of, e.g., change of the provider of the Internet, failure in the electricity or Internet services, changes of Wi-Fi routers or even moving of the family from one apartment to another. All such situations needed an assistance of the project team and cooperation of the households owners. Thanks to the surprisingly positive attitude of End Users, all interventions have been successively carried out.

8. Results of the study

The results of the study is shown as "data of consumption of water are gathered and summarized for each household before and after our intervention strategies were implemented. The difference shows the efficiency of the DSS". The comparison periods are June to December of 2015 and 2016 respectively. Three groups of households are participating in the comparison. First group came from Skiathos, second group from Sosnowiec, both of the groups are installed the water supply meter in the household. The third group came from households in Sosnowiec, where the lump sum payment is used in the absence of the water supply meter in the household. The detail are given in the evaluation report D7.4

In Skiathos, ten out of 20 households were selected in this group for water consumption comparison. The unselected households are either installing very few sensors and lost the representative or the monitoring system or the DDS system have been stopped working for some time during the comparison period. Table 5 gives the average monthly water consumption for the comparison period. The water saving percentages for each month are shown in the second half of Table 4. Ignoring the holiday time from July to November, water consumption has been reduced to 93.3% and 33.30% in June and December respectively.

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As described previously the comparison period is from June to December 2015 and 2016. Eight out of 20 households were selected in Sosnowiec for water consumption comparison. Other ten households were grouped in another group. The unselected two households are either installing very few sensors and lost the representative or the monitoring system or the DDS system have been stopped working for some time during the comparison period. Only the average monthly water consumption is compared in Table 6. The water saving percentage for each month is shown in the second half of Table 5. In June and December the water consumption has been reduced to 90.20% and 117.38% respectively.

The third group represents households where the lump sum payment is used in the absence of the water supply meter in the household in Sosnowiec. Ten households were selected in this group for water consumption comparison. Table 7 gives the average monthly water consumption for the comparison period. The water saving percentage is shown in the second half of Table 7. In June and December the water consumption have been saved to 98.64% and 72.35% respectively.

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Table 5: Average monthly water consumption in Skiathos in 2015 and 2016

Average monthly water consumption in 2015 [L]													
RouterId	June		July		August		September		October		November		December
12	74,95		100,08		95,13		66,52		19,73		15,92		18,28
16	25,68		46,27		41,05		30,85		~~22,05~~		17,99		14,04
18	7,08		~~0~~		1,05		2,75		3,30		4,65		~~3,73~~
19	~~12,51~~		~~0~~		~~0~~		5,24		6,53		21,27		~~0~~
1a	~~12,15~~		~~10,23~~		~~8,26~~		~~3,66~~		13,13		~~0~~		43,40
1b	2,03		2,26		1,13		1,99		0,66		3,04		0,81
1c	25,62		25,47		18,59		20,41		16,53		10,59		10,10
7	105,38		135,82		58,43		~~0~~		19,95		~~27,87~~		~~30,09~~
d	35,18		45,07		43,87		55,02		~~0~~		~~0~~		69,58
Total	275,92		354,97		259,24		182,78		79,82		73,46		156,21

Average monthly water consumption in 2016 [L] and dynamics indicators														
RouterId	June	Rate	July	Rate	August	Rate	September	Rate	October	Rate	November	Rate	December	Rate
12	109,08	145,53%	85,34	85,28%	109,88	115,51%	96,40	144,91%	5,68	28,79%	2,49	15,64%	15,87	86,84%
16	11,94	46,48%	19,10	41,27%	18,74	45,66%	5,24	17,00%	~~0~~	~~0,00%~~	2,35	13,07%	2,11	15,03%
18	2,73	38,59%	~~2,16~~	~~0,00%~~	2,22	212,29%	2,225	80,85%	2,8	84,96%	6,572	141,23%	~~0~~	~~0,00%~~
19	~~0~~	~~0,00%~~	~~0~~	~~0,00%~~	~~0~~	~~0,00%~~	5,75	109,80%	0,64	9,81%	1,95	9,17%	~~0~~	~~0,00%~~
1a	~~0~~	~~0,00%~~	~~0~~	~~0,00%~~	~~0~~	~~0,00%~~	~~0~~	~~0,00%~~	6,76	51,49%	4	~~0,00%~~	0,25	0,58%
1b	1,06	52,10%	2,66	117,70%	1,77	156,89%	9,24	463,70%	6,24	950,55%	6,44	212,02%	3,12	386,32%
1c	14,79	57,75%	12,03	47,24%	16,47	88,59%	19,96	97,82%	19,86	120,13%	18,62	175,85%	11,06	109,49%
7	83,38	79,12%	95,15	70,06%	75,50	129,21%	~~83,07~~	~~0,00%~~	54,04	270,82%	~~0~~	~~0,00%~~	~~0~~	~~0,00%~~
d	34,46	97,95%	30,27	67,15%	31,93	72,78%	37,13	67,49%	~~69,30~~	~~0,00%~~	~~61,91~~	~~0,00%~~	19,60	28,17%
Total	257,44	93,30%	244,55	68,89%	256,51	98,95%	175,95	96,26%	96,02	94,26%	38,42	52,31%	52,02	33,30%

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Table 6. Average monthly water consumption in Sosnowiec in 2015 and 2016

Average monthly water consumption in 2015 [L]													
RouterId	June		July		August		September		October		November		December
1	44,11		17,8558		70,33		32,81		35,79		58,543		66,349677
2	197,905		127,56		113,797		148,838		121,636		139,85033		~~155,31~~
3	27,5869		31,64		~~0~~		~~0~~		48,5382		48,001		24,09
4	132,57		~~0~~		4,67		170,532222		162,165		202,40056		164,80214
5	40,445		65,35		74,8375		32,4475		51,7983		54,305833		61,238889
8	127,51		103,38		150,125		83,732		97,8714		99,726		114,89742
c	174,903		157,80		183,71		110,67		179,046		132,66655		150,09897
e	75,98		77,47		93,25		83,81		77,29		83,326333		96,966452
Total	821,01		581,06		690,71		662,84		774,14		818,82		678,44
Average monthly water consumption in 2016 [L] and dynamics indicators													
RouterId	June	Rate	July	Rate	August	Rate	September	Rate	October	Rate	November	Rate	December	Rate
1	43,68	99,03%	36,6633	205,33%	38,23	54,37%	28,6584211	87,35%	14,3116	39,99%	6,2628	10,70%	26,924	40,58%
2	114,70	57,96%	128,02	100,36%	97,67	85,83%	128,394615	86,26%	147,985	121,66%	150,13	107,35%	~~0~~	~~0,00%~~
3	0,3875	1,40%	13,9731	44,16%	~~30,145~~	~~0,00%~~	~~34,883~~	~~0,00%~~	50,2294	103,48%	34,083667	71,01%	34,69	144,02%
4	181,52	136,93%	~~160,31~~	~~0,00%~~	165,22	3537,93%	185,430385	108,74%	203,366	125,41%	164,39692	81,22%	178,94	108,58%
5	53,33	131,87%	52,5661	80,44%	112,064	149,74%	111,506667	343,65%	114,145	220,36%	102,52429	188,79%	120,9725	197,54%
8	112,99	88,61%	71,34	69,01%	91,60	61,01%	98,3292308	117,43%	112,408	114,85%	111,66733	111,97%	116,22548	101,16%
c	156,437	89,44%	125,93	79,80%	156,18	85,01%	152,574	137,86%	160,483	89,63%	138,79933	104,62%	153,02645	101,95%
e	77,5144	102,02%	133,80	172,72%	133,87	143,56%	116,3036	138,78%	91,2016	118,00%	108,92033	130,72%	165,55871	170,74%
Total	740,56	90,20%	562,30	96,77%	794,84	115,07%	821,20	123,89%	894,13	115,50%	816,78	99,75%	796,34	117,38%

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Table 7: Average monthly water consumption in Sosnowiec in 2015 and 2016

Monthly water consumption in 2015 [L]												
RouterId	June		July		August		September		October		November		December
102	8119		8521		8817		8114		8153		8577		9851
109	4426		3138		3797		7420		7076		6779		7403
206	10834		13198		13572		12890		12389		14058		11728
210	9567		16475		10460		11097		29013		31651		31948
213	12876		12904		13116		14463		12255		12510		15225
301	5009		5845		6286		4725		4561		3939		4058
305	11390		8813		6138		10399		9970		10066		7734
312	20895		22444		22091		19678		20390		20521		20602
405	6420		5445		7913		7401		7533		9183		7719
Total	89536		96783		92190		96187		111340		117284		116268

Monthly water consumption in 2016 [L] and dynamics indicators														
RouterId	June	Rate	July	Rate	August	Rate	September	Rate	October	Rate	November	Rate	December	Rate
102	4522	55,70%	3358	39,41%	5919	67,13%	7022	86,54%	3927	48,17%	3953	46,09%	8928	90,63%
109	5357	121,04%	4590,3	146,28%	4402	115,92%	5098,5	68,71%	5753,9	81,32%	4700,52	69,34%	5358,54	72,38%
206	11661	107,63%	11590	87,82%	13390	98,66%	12588	97,66%	12273	99,06%	12238	87,05%	14267	121,65%
210	19948	208,51%	18850	114,42%	16557	158,29%	23245	209,47%	18289	63,04%	19586	61,88%	22401	70,12%
213	12698	98,62%	12269	95,08%	10378	79,12%	8994	62,19%	9625	78,54%	10526	84,14%	10203	67,01%
301	6122	122,22%	4337	74,20%	4750	75,56%	4619	97,76%	4732	103,75%	5012	127,24%	3371	83,07%
305	8670	76,12%	7726	87,67%	5866	95,57%	5133	49,36%	11403	114,37%	10764	106,93%	790	10,21%
312	10418	49,86%	16148	71,95%	16132	73,03%	11536	58,62%	14420	70,72%	12798	62,37%	11888	57,70%
405	8920	138,94%	7186	131,97%	5279	66,71%	7351	99,32%	7976	105,88%	6830	74,38%	6910	89,52%
Total	88316	98,64%	86054	88,91%	82673	89,68%	85586,5	88,98%	88399	79,40%	86407,52	73,67%	84116,54	72,35%

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9. English version of the user manual

In addition to the Configuration tab, the front menu displays DSS operational tabs. By selecting different tabs, the relevant information will be displayed.

9.1 Daily usage

The graph in the top part of the daily usage screen displays the last 23 hours' water usage in litres per minute. The dials below show the last water usage for each appliance.

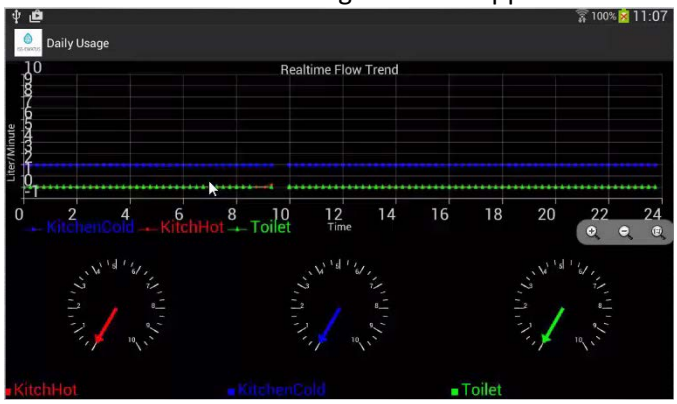

Figure 6. Daily usage

9.2 News

This tab provides information broken down into three categories: Water Saving, Environment Impact and General Knowledge. Click on a tab or swipe the screen to switch between categories. Clicking on a tips title displays the tip. After reading, click 'ok' to return.

Figure 7. Tips

End users are only presented with tips which are relevant to their situation. Relevance is determined by models of historic and predicted water usage. Some tips include web links to relevant external sources. Tips include:

1. *Fix leaky tap* is shown when the system detects uninterrupted water usage across a protracted period.
2. *You are above average:* is shown when the water usage from the previous day exceeds the average for the whole neighbourhood.
3. *Increased water usage* is generated by an increase of more than 15% day-to-day
4. *Heavy user* indicates the household is one of the 10 highest users in their neighbourhood.
5. *Be proud!* Is the opposite of above situation, when the household is among 10 users with minimal water usage.

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6. *Are you in a hurry?* Is generated when the household is among the 10% who use water most often. Here, we also ask the user to look for faulty taps and leaks.
7. *Disciplined* is the opposite of the above tip.
8. *Increasing* trend is computed using the Linear Regression model and is shown when the monthly trend for the user predicts elevated water usage.
9. *Decreasing trend* is the opposite of the above tip.
10. *Expected water usage* is a fully personalized tip which uses the ARIMA model to predict the expected water usage for the following day.
11. *Water in kitchen* is shown as a warning to those users who have the biggest water usage in the kitchen. This tip also suggests installing special equipment in the kitchen to save more water (e.g. tap aerators).
12. *Water in bathroom* is for bathroom appliances. The user is presented with a web link where he or she can check whether their appliances are water-saving.
13. *Shower water* is shown when the shower usage for the household is particularly high.
14. *Toilet flush* is generated when the toilet usage is abnormally high. The user is then presented with a tip involving the installation of a dual-flush toilet.

9.3 Rate Diagram

The rate diagram screen provides a water consumption benchmark that allows the user to compare their household's recent daily monitored water consumption against their historical average. Seven 'current trend' boxes display daily water consumption in litres across the previous week (with -7 referring to seven days previously and -1 referring to the previous day). These boxes are colour coded and aligned with a rating schema. Darkest green indicates very low household consumption (Band A: at least 30% below the household's historical average). Yellow (Band D) indicates the historical average. Red (Band G) indicates very high water consumption (at least 30% higher than the household's historical average).

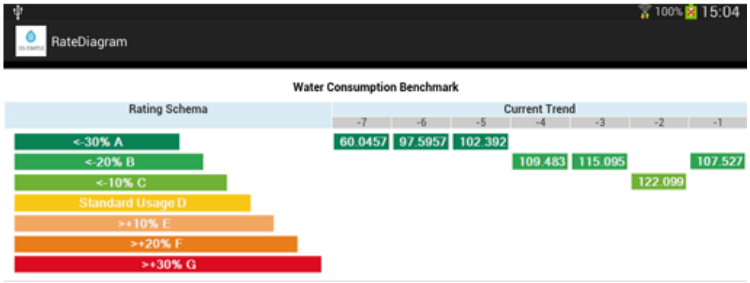

Figure 8. Rate diagram

9.4 Summary diagram

The summary diagram page provides information on your household's water consumption, in litres, for different appliances within your home. The first three symbols indicate kitchen taps, dishwasher and bathroom taps. The next three indicate washing machine, toilet and shower. Use the tabs to choose the time frame for the display. This can be daily (last seven days), weekly (last four weeks) or monthly (last

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three months).

Figure 9. Summary diagram daily, weekly, and monthly

9.5 Goal setting

The Goal setting page gives you a summary of your household consumption, in litres, across the last seven days and 30 days. It allows you to set a target for reducing your household's water consumption and to monitor your daily progress towards this goal. You can choose a target consumption that is 10%, 20%, 30% or 40% below your historical consumption. The goal settings are immediately calculated to reflect your choice. Feedback on recent consumption is colour coded; green indicates that the goal has been reached and red indicates it has not.

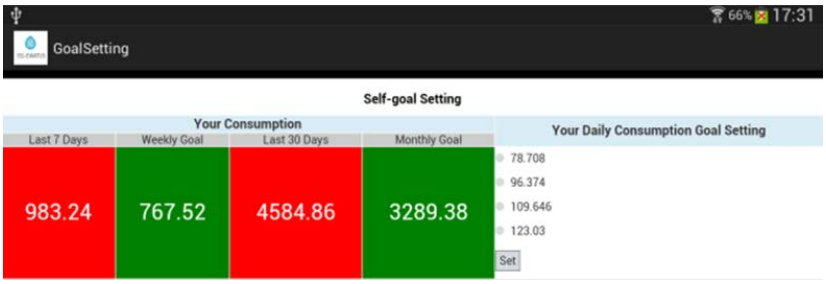

Figure 10. Goal setting

9.6 Water Diary

Water Diary is an app in the form of a household water use diary. It presents water use events derived from sensor data and enables household members to declare who used the water. This allows users to identify which household member, and which activities, consume the largest volume of water. This feature increases the quantity and granularity of water consumption information available to households. It also exposes individual consumers to the gaze and water-related attitudes and subjective norms of other household members.

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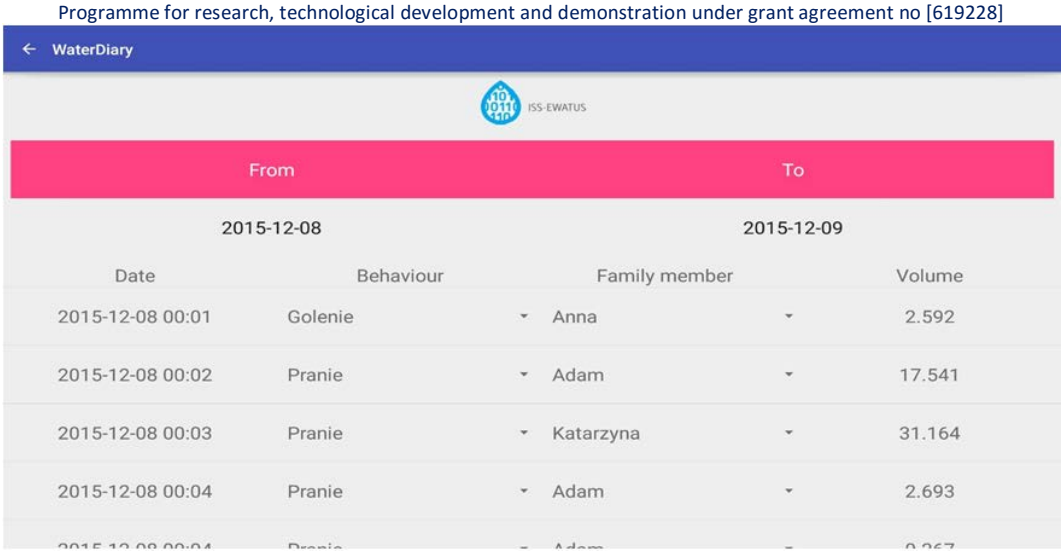

Figure 11. Water diary

9.7 Water user classification

Like the WaterDiary, the water user classification (WUC) function seeks to attribute consumption to individuals rather than the ambient household. In addition, it introduces a consideration of attitudes towards the environment with the intention of provoking cognitive dissonance among environmentally-aware consumers with wasteful water use routines or inefficient household appliances. It collects survey data from individual household members relating to their showering and laundry habits, household appliance efficiency and level of environmental concern.

The WUC juxtaposes an individual's position on technological (efficiency), usage (curtailment), and environmental (attitude) dimensions. Personalized feedback highlights where technology and/or user behaviour are at odds with the consumer's environmental attitudes. Recognition of this discrepancy may invoke cognitive dissonance and motivate users to modify their behaviour or appliances. The WUC also presents tailored information about potential water saving actions. Unlike the autonomic household DSS, this feedback is personalized to the individual rather than the household.

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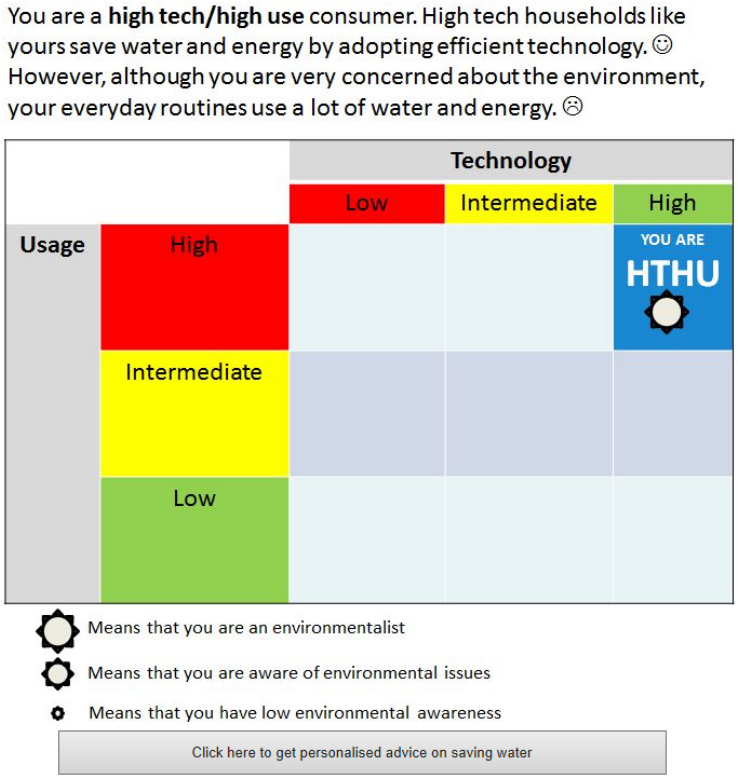

Figure 12. Water user classification

10. Greek version of the user manual.

Εγχειρίδιο για το Σύστημα Υποστήριξης αποφάσεων για Νοικοκυριά

Εκτός από την καρτέλα της Διαμόρφωσης, το μπροστινό μενού του DSS εμφανίζει τις καρτέλες χρήσης. Επιλέγοντας διαφορετικές καρτέλες, θα εμφανιστούν οι σχετικές πληροφορίες.

10.1 Καθημερινή χρήση

Το γράφημα στο πάνω μέρος της οθόνης της καθημερινής χρήσης εμφανίζει τις τελευταίες 23 ώρες της χρήσης νερού σε λίτρα ανά λεπτό. Οι παρακάτω πίνακες παρουσιάζουν την τελευταία χρήση νερού για κάθε συσκευή..

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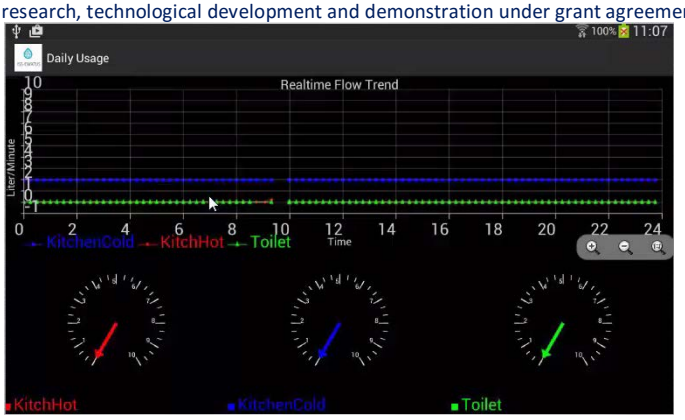

Διάγραμμα 6. Καθημερινή χρήση

10.2 Νέα

Αυτή η καρτέλα παρέχει πληροφορίες οι οποίες κατανέμονται σε τρεις κατηγορίες: Εξοικονόμηση Νερού, Περιβαλλοντικές Επιπτώσεις και Γενική Γνώση. Κάντε κλικ σε μια καρτέλα ή σύρετε την οθόνη για εναλλαγή μεταξύ των κατηγοριών. Κάνοντας κλικ στις συμβουλές ενός τίτλου, σχετικές συμβουλές εμφανίζονται στην οθόνη. Μετά την ανάγνωση, κάντε κλικ στο «OK» για να επιστρέψετε.

Διάγραμμα 7. Συμβουλές

Στους τελικούς χρήστες παρουσιάζονται μόνο οι συμβουλές που σχετίζονται με την κατάστασή τους. Η συνάφεια καθορίζεται από τα μοντέλα του ιστορικού και την προβλεπόμενη χρήση του νερού. Μερικές συμβουλές περιλαμβάνουν συνδέσμους σε σχετικές εξωτερικές πηγές. Οι συμβουλές που εμφανίζονται είναι οι εξής:

1. Η συμβουλή *«Διόρθωσε τις διαρροές βρύσης»* εμφανίζεται όταν το σύστημα ανιχνεύσει αδιάκοπη χρήση νερού για μια παρατεταμένη περίοδο.
2. Η συμβουλή *«Είστε άνω του μέσου όρου»* εμφανίζεται όταν η χρήση του νερού από την προηγούμενη ημέρα υπερβαίνει το μέσο όρο για το σύνολο της γειτονιάς.
3. Η συμβουλή «*Αυξημένη χρήση νερού*» παράγεται από μια αύξηση άνω του 15% από ημέρα σε ημέρα.
4. *«Βαρέα χρήση»* δηλώνει ότι το νοικοκυριό είναι ένα από τα 10 υψηλότερα σε χρήση νερού στη γειτονιά του.
5. *«Να είστε υπερήφανοι»* είναι ακριβώς το αντίθετο από το προηγούμενο, όπου το νοικοκυριό είναι ένα από τα 10 χαμηλότερα σε χρήση νερού στη γειτονιά του.
6. *«Βιάζεστε?»* Αυτή η συμβουλή παράγεται όταν το νοικοκυριό είναι στο 10% αυτών που χρησιμοποιούν νερό συχνότερα. Εδώ επίσης επισημαίνουμε στο χρήστη να κοιτάξει για διαρροές και προβλήματα στις βρύσες.
7. «*Πειθαρχημένος*» Είναι ακριβώς το αντίθετο από το προηγούμενο.
8. *«Αυξητική τάση»* υπολογίζεται χρησιμοποιώντας το μοντέλο γραμμικής παλινδρόμησης και εμφανίζεται όταν η μηνιαία τάση για το χρήστη προβλέπει αυξημένη χρήση του νερού.
9. *«Πτωτική τάση»* Είναι ακριβώς το αντίθετο από το προηγούμενο.
10. *«Αναμενόμενη χρήση νερού»* είναι μια πλήρως εξατομικευμένη συμβουλή που χρησιμοποιεί το μοντέλο ARIMA να προβλέψει την αναμενόμενη χρήση νερού για την επόμενη ημέρα.

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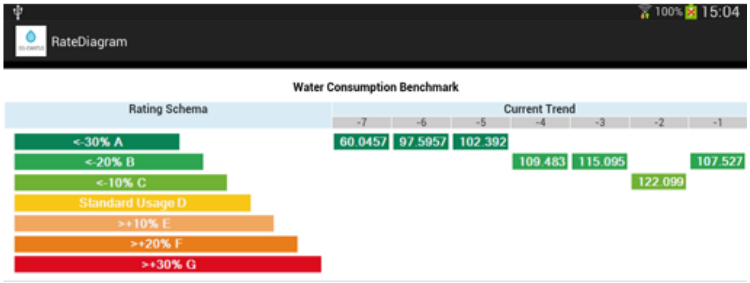
11. *«Νερό στην κουζίνα»* εμφανίζεται ως προειδοποίηση προς τους χρήστες που έχουν τη μεγαλύτερη χρήση νερού στην κουζίνα. Αυτή η συμβουλή προτείνει επίσης την εγκατάσταση ειδικού εξοπλισμού στην κουζίνα για να σώσει περισσότερο νερό (π.χ. συσκευές αερισμού στη βρύση).
12. *«Νερό στο μπάνιο»* είναι το μήνυμα για τις συσκευές του μπάνιου. Στον χρήστη εμφανίζεται ένας σύνδεσμος όπου μπορεί να ελέγξει εάν οι συσκευές του σώζουν νερό.
13. *«Νερό του ντουζ»* το μήνυμα εμφανίζεται όταν η χρήση του νερού του ντουζ είναι ιδιαίτερα υψηλή.
14. *«Χρήση Τουαλέτας»* το μήνυμα παράγεται όταν η χρήση της τουαλέτας είναι ιδιαίτερα υψηλή. Στον χρήστη τότε εμφανίζεται μια συμβουλή να εγκαταστήσει καζανάκι με διπλό κουμπί (μισή χρήση νερού).

10.3 Διάγραμμα Βαθμολόγησης

Η οθόνη διάγραμμα ρυθμού/βαθμολόγησης παρέχει ένα σημείο αναφοράς της κατανάλωσης νερού που επιτρέπει στο χρήστη να συγκρίνει τις πρόσφατες καθημερινά καταναλώσεις νερού του νοικοκυριού του σχετικά με τον ιστορικό μέσο όρο. Επτά κουτιά με την ένδειξη «τρέχουσα τάση» εμφανίζουν την ημερήσια κατανάλωση νερού σε λίτρα για όλη την προηγούμενη εβδομάδα (με -7 να αναφέρεται στις επτά προηγούμενες ημέρες και το -1 αναφέρεται στην προηγούμενη ημέρα). Αυτά τα κουτιά έχουν χρώμα που κωδικοποιείται και είναι ευθυγραμμισμένα με ένα σχήμα αξιολόγησης. Το σκούρο πράσινο υποδεικνύει πολύ χαμηλή κατανάλωση (Band A: τουλάχιστον 30% κάτω από τον ιστορικό μέσο όρο). Κίτρινο (Band D) υποδεικνύει το ιστορικό μέσο όρο. Κόκκινο (Band G) υποδεικνύει πολύ υψηλή κατανάλωση νερού (τουλάχιστον 30% υψηλότερη από τον ιστορικό μέσο όρο).



Διάγραμμα 8. Σχήμα αξιολόγησης/βαθμολόγησης

10.4 Σχήμα περίληψης

Η σελίδα με το διάγραμμα της περίληψης παρέχει πληροφορίες σχετικά με την κατανάλωση νερού του νοικοκυριού σε λίτρα, για διάφορες συσκευές μέσα στο σπίτι. Τα πρώτα τρία σύμβολα δείχνουν τις βρύσες κουζίνας, το πλυντήριο πιάτων και τις βρύσες του μπάνιου. Τα επόμενα τρία δείχνουν το πλυντήριο, την τουαλέτα και το ντους. Χρησιμοποιήστε τις καρτέλες για να επιλέξετε το χρονικό πλαίσιο για την εμφάνιση. Αυτό μπορεί να είναι καθημερινή (τελευταίες επτά ημέρες), εβδομαδιαία (τελευταίες τέσσερις εβδομάδες) ή μηνιαία (τρεις τελευταίους μήνες).

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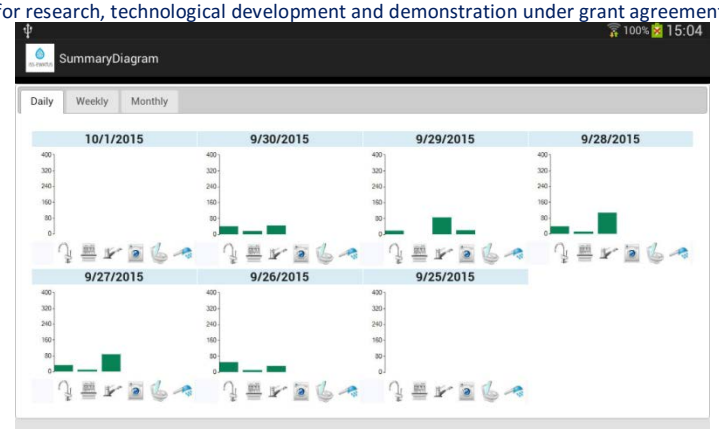
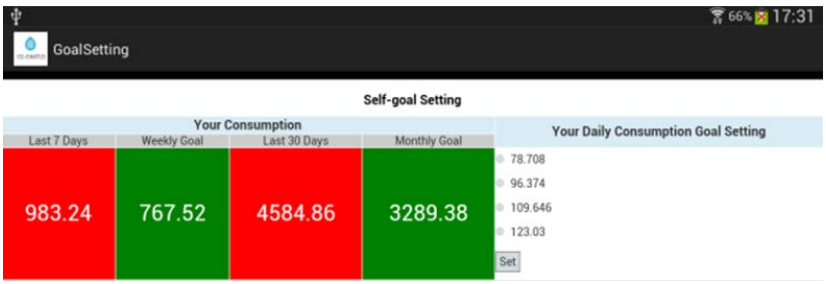


Διάγραμμα 9. Καθημερινές, εβδομαδιαίες και μηνιαίες περιλήψεις.

10.5 Ρύθμιση στόχου

Η σελίδα ρύθμιση στόχου δίνει μια περίληψη της κατανάλωσης νοικοκυριού, σε λίτρα, σε όλες τις τελευταίες επτά ημέρες και 30 ημέρες. Σας επιτρέπει να ορίσετε ένα στόχο για τη μείωση της κατανάλωσης νερού του νοικοκυριού σας και να παρακολουθεί καθημερινά την πρόοδό σας προς αυτή την κατεύθυνση. Μπορείτε να επιλέξετε μια κατανάλωση «στόχο» που μπορεί να είναι 10%, 20%, 30% ή 40% κάτω από την προηγούμενη κατανάλωσή σας. Οι ρυθμίσεις του στόχου υπολογίζονται αμέσως έτσι ώστε να αντανακλούν την επιλογή σας. Η ανατροφοδότηση σχετικά με την πρόσφατη κατανάλωση είναι κωδικοποιημένη με χρώματα: το πράσινο υποδεικνύει ότι ο στόχος έχει επιτευχθεί και το κόκκινο δηλώνει ότι δεν έχει.



Διάγραμμα 10. Ρύθμιση στόχου

10.6 Ημερολόγιο νερού

Το Water Diary είναι μια εφαρμογή με τη μορφή ενός ημερολογίου οικιακής χρήσης νερού. Παρουσιάζει τα γεγονότα της χρήσης του νερού που προέρχεται από δεδομένα από αισθητήρες και επιτρέπει στα μέλη της οικογένειας να δηλώσει ποιος χρησιμοποίησε το νερό. Αυτό επιτρέπει στους χρήστες να εντοπίζουν ποιά μέλη της οικογένειας και ποιές δραστηριότητες καταναλώνουν το μεγαλύτερο όγκο του νερού. Το χαρακτηριστικό αυτό αυξάνει την ποσότητα και την πυκνότητα των πληροφοριών κατανάλωσης νερού που είναι διαθέσιμες. Δείχνει επίσης μεμονωμένους καταναλωτές και την στάση τους σχετικά με το νερό καθώς και το κοινωνικό πρότυπο των άλλων μελών της οικογένειας.

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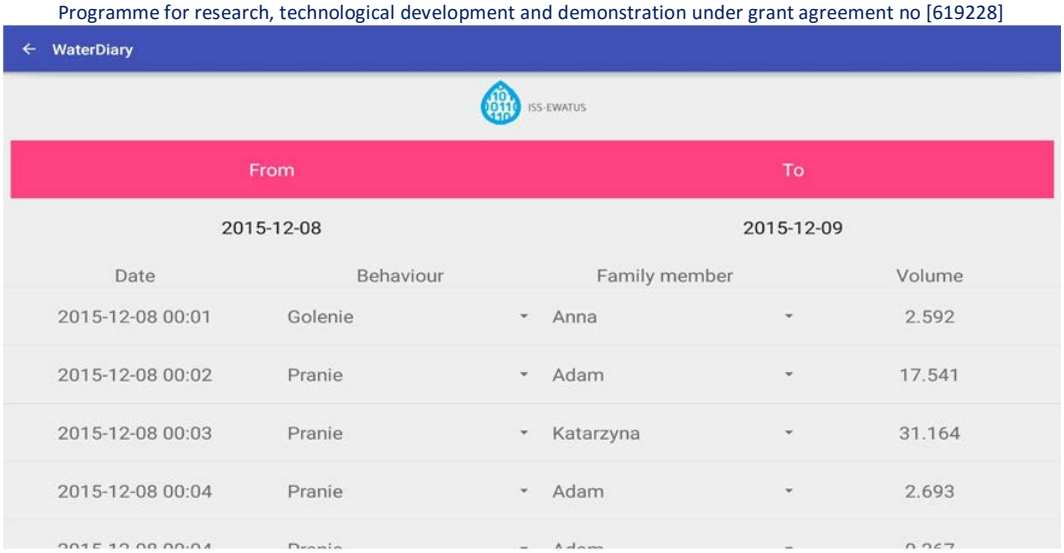

Διάγραμμα 11. Ημερολόγιο νερού

10.7 Κατηγοριοποίηση χρηστών νερού.

Όπως και το WaterDiary, η (WUC) συνάρτηση ταξινόμησης/κατηγοριοποίησης των χρηστών νερού επιδιώκει να αποδώσει την κατανάλωση σε μεμονωμένα άτομα και όχι συνολικά στο σπίτι. Επιπλέον, εισάγει μια εξέταση της στάσης απέναντι στο περιβάλλον με την πρόθεση να προκαλέσει γνωστική ασυμφωνία μεταξύ καταναλωτών με περιβαλλοντική συνείδηση με ρουτίνες σπάταλης χρήσης νερού ή αναποτελεσματικές οικιακές συσκευές. Συλλέγει στοιχεία της έρευνας από μεμονωμένα μέλη της οικογένειας που σχετίζονται με το ντους τους και τις συνήθειες πλύσης των ρούχων, αποτελεσματικότητας των οικιακών συσκευών και το επίπεδο της περιβαλλοντικής ανησυχίας.

Η συνάρτηση WUC αντιπαραθέτει τη θέση του ατόμου στην τεχνολογική (επίδοση) διάσταση, την χρήση (περικοπή) και την περιβαλλοντική διάσταση. Η εξατομικευμένη ανατροφοδότηση υπογραμμίζει τα σημεία όπου η τεχνολογία ή/και η συμπεριφορά των χρηστών έρχονται σε αντίθεση με τις περιβαλλοντικές τάσεις του καταναλωτή. Η αναγνώριση αυτής της διαφοράς μπορεί να επικαλεστεί γνωστική ασυμφωνία και να παρακινήσει τους χρήστες να τροποποιήσουν τη συμπεριφορά τους ή τις συσκευές τους. Η WUC παρουσιάζει επίσης προσαρμοσμένες πληροφορίες σχετικά με πιθανές δράσεις εξοικονόμησης νερού. Σε αντίθεση με το αυτόνομο DSS για νοικοκυριά, αυτή η ανατροφοδότηση είναι εξατομικευμένη για το άτομα και όχι ολόκληρη την οικογένεια.

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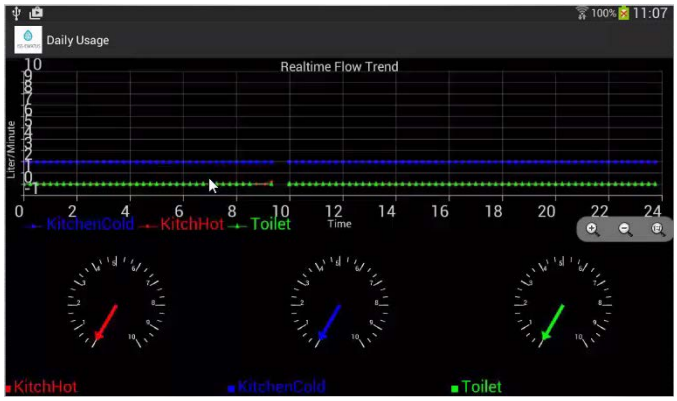
11. Polish version of the user manual.

Instrukcja obsługi domowego systemu wspomagania decyzji

11.1 Daily usage (Zużycie dzienne)

Wykres znajdujący się w górnej części ekranu dziennego zużycia zawiera informacje na temat ilości wody wykorzystanej w okresie ostatnich 23 godzin. Dane te prezentowane są w litrach na godzinę. Znajdujące się poniżej wskaźniki w postaci tarcz zegarów wyświetlają dane na temat ostatniego zużycia zarejestrowanego przez poszczególne urządzenia pomiarowe.



Rysunek 1 Dzienne zużycie

11.2 Aktualności

Zakładka ta dostarcza informacji, które podzielone zostały na trzy kategorie: Oszczędzanie wody, Wpływ na środowisko, Wiedza ogólna. W celu przełączania pomiędzy kategoriami należy wybrać odpowidnią zakładkę lub przesunąć ekran. Wybór tytułu porady skutkuje jej wyświetleniem. Po jej przeczytaniu należy wybrać "ok" by powrócić do listy porad.

Rysunek 2 Porady

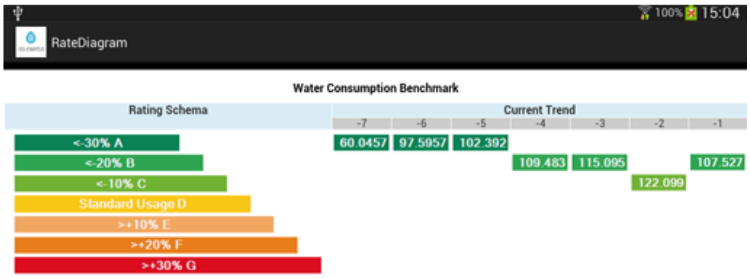
Użytkownikom końcowym prezentowane są wyłącznie te porady, które odnoszą się do ich sytuacji tzn. mają szanse poprawić ich efektywność korzystania z wody. To jaka porada jest prezentowana danemu użytkownikowi determinują modele historycznego i przewidywanego zużycia. Niektóre porady zawierają odnośniki do odpowiadających im zewnętrznych źródeł. Do zbioru porad należą:

15. *Fix leaky tap* – porada wyświetlana w sytuacji kiedy system wykryje ciągłe zużycie wody na przestrzeni dłuższego okresu.
16. *You are above average:* - porada wyświetlana kiedy zużycie wody poprzedniego dnia przekroczyło przeciętne zużycie całego sąsiedztwa.
17. *Increased water usage* – porada wyświetlana kiedy dzienne zużycie wody wzrosło o więcej niż 15% w stosunku do dnia poprzedniego.

18. *Heavy user* – porada ta informuje użytkownika, że jego gospodarstwo domowe należy do grona 10 gospodarstw o najwyższym zużyciu wody w sąsiedztwie
19. *Be proud!* – porada przeciwna względem poprzedniej, wyświetlana kiedy gospodarstwo należy do grona 10 gospodarstw o najmniejszym zużyciu wody w sąsiedztwie.
20. *Are you in a hurry?* – porada wyświetlana kiedy gospodarstwo należy do 10% gospodarstw, w których zużycie wody następuje najczęściej. Porada ta ma także na celu zwrócenie uwagi użytkownika na wadliwe oraz cieknące krany.
21. *Disciplined* – porada przeciwna do powyższej.
22. *Increasing* – porada wyświetlana na podstawie trendu zużycia wody wyznaczonego przy pomocy modelu uzyskanego metodą regresji liniowej. Wyświetlenie porady następuje gdy miesięczny trend przewiduje zwiększone zużycie wody.
23. *Decreasing trend* – porada przeciwna do powyższej.
24. *Expected water usage* – porada w pełni dedykowana. Przy jej generowaniu wykorzystywany jest model ARIMA, który przewiduje zużycie wody następnego dnia.
25. *Water in kitchen* – porada wyświetlana jako ostrzeżenie tym użytkownikom, którzy mają najwyższe zużycie wody w kuchni. Porada sugeruje zaopatrzenie się w urządzenia pozwalające na zaoszczędzenie wody (np. areator).
26. *Water in bathroom* – porada dla urządzeń w łazience. Prócz porady użytkownik otrzymuje możliwość skorzystania z odnośnika, pod którym może sprawdzić czy posiadane przez niego urządzenia są wodooszczędne.
27. *Shower water* – porada prezentowana, gdy woda w gospodarstwie domowym zużywana jest na prysznic w szczególnie dużych ilościach.
28. *Toilet flush* – porada wyświetlana, gdy zużycie wody w spłuczce jest nadmiernie wysokie. Użytkowniki zostaje poinformowany także o możliwości instalacji spłuczki dwukomorowej.

11.3 Efektywność użycia wody

Ekran efektywności użycia wody przedstawia zestawienie pozwalające użytkownikowi na porównanie zużycia wody w jego gospodarstwie domowym w przeciągu ostatnich dni w odniesieniu do historycznej średniej. Siedem wartości widocznych w diagramie "Aktualny trend" przedstawia dzienne zużycie wody (w litrach) w minionym tygodniu (-7 odnosi się do dnia, który minął 7 dni temu względem dnia bieżącego, a -1 do dnia poprzedniego względem bieżącego dnia). Rozmieszczenie oraz kolor tła, na którym umieszczone zostały poszczególne wartości odpowiadają efektywności użycia wody danego dnia. Najciemniejsza zieleń oznacza bardzo niskie zużycie w ramach gospodarstwa (co najmniej 30% poniżej historycznej średniej). Kolor żółty oznacza historyczną średnią. Kolor czerwony wskazuje na bardzo wysokie zużycie (co najmniej 30% większe niż historyczna średnia gospodarstwa).



Rysunek 3 Wykres miary efektywności zużycia wody

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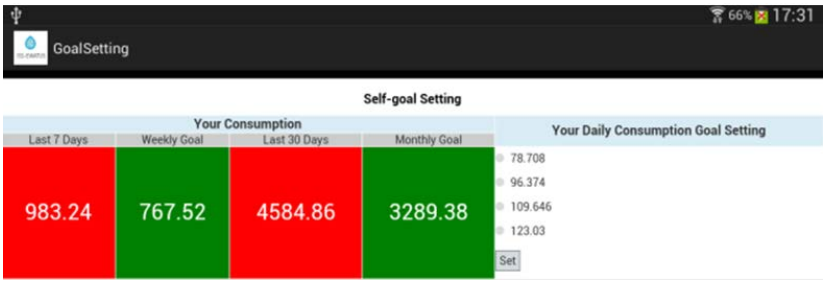
11.4 Podsumowanie zużycia wody

Wykres podsumowujący zużycie wody dostarcza informacji ile litrów wykorzystano przy pomocy poszczególnych urządzeń. Pierwsze trzy symbole oznaczają kran kuchenny, zmywarkę, kran w łazience. Kolejne trzy to pralka, toaleta (spłuczka) oraz prysznic. Chcąc zobaczyć podsumowanie w ujęciu dziennym (ostatnie 7 dni), tygodniowym (ostatnie 4 tygodnie) lub miesięcznym (ostatnie 3 miesiące) należy wybrać odpowiednią zakładkę.

Rysunek 4 Podsumowanie zużycia wody dzienne, tygodniowe, miesięczne

11.5 Ustawienia celu

Ekran ustawienia celu prezentuje podsumowanie zużycia wody (w litrach) w gospodarstwie domowym w okresie ostatnich siedmiu oraz 30 dni. Dodatkowo ekran ten pozwala na wybór celu, którego realizacja poskutkuje zmniejszeniem zużycia wody oraz na monitorowanie postępów dokonywanych na drodze do jego realizacji. Użytkownik może wybrać jako swój cel redukcje zużycia wody o 10%, 20%, 30% lub 40% względem swojego dotychczasowego zużycia. Informacja o tym czy zakładany cel udało się zrealizować przekazywana jest poprzez kolor tła, na którym umieszczono ilość zużytej wody wyrażoną w litrach. Kolor zielony oznacza, że cel został osiągnięty, a czerwony, że celu nie udało się zrealizować.



Rysunek 5 Ustawienia celu

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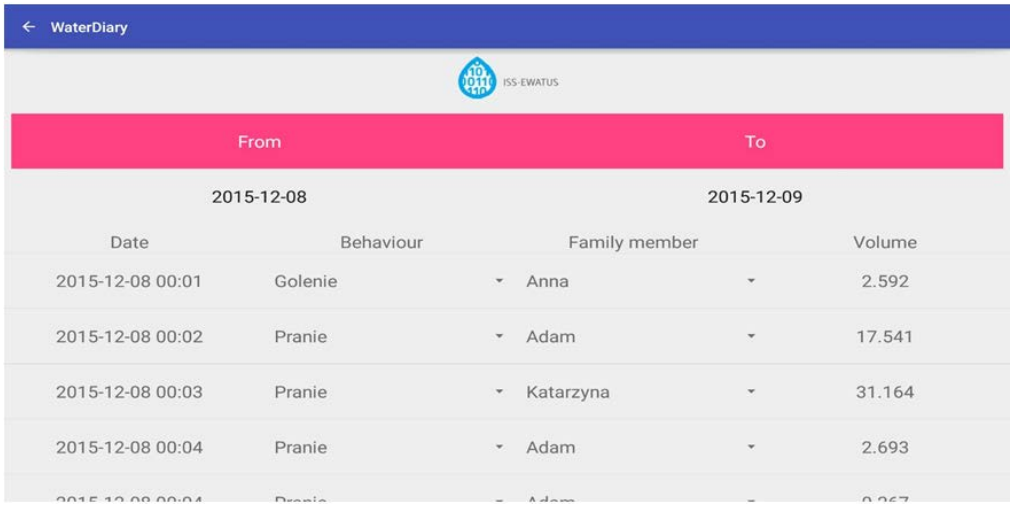
11.6 Dziennik wodny (ang. WaterDiary)

WaterDiary to aplikacja stanowiąca swego rodzaju dziennik zużycia wody. Prezentuje ona wszystkie zużycia zarejestrowane przez czujniki oraz pozwala członkom gospodarstwa domowego na ich identyfikację – określenie kto dokonał danego zużycia. Dzięki tym informacjom możliwe jest wygenerowanie zestawień prezentujących, kto zużywa najwięcej wody oraz na jaki cel przeznaczana jest jej największa ilość. Funkcja ta podnosi jakość oraz szczegółowość informacji na temat zużycia wody dostępnych dla gospodarstwa domowego. Poza tym poszczególni członkowie gospodarstwa zyskują pogląd na efektywność zużycia wody przez innych członków gospodarstwa.



Rysunek 6 Water diary

11.7 Klasyfikacji użytkowników wody

Podobnie jak w przypadku WaterDiary, funkcja klasyfikacji użytkowników wody (WUC) ma za zadanie przypisanie do zużycia konkretnego użytkownika a nie gospodarstwa, w którym dokonano zużycia. Ponadto funkcja ta ma za zadanie zwrócenie uwagi użytkowników na niekorzystny wpływ jaki wywierają na środowisko poprzez przyzwyczajenia, w skutek których marnują zasoby wodne, oraz korzystanie z mało efektywnych urządzeń AGD. W ramach WUC przeprowadzana jest ankieta, w której poszczególni członkowie gospodarstwa domowego odpowiadają na pytania dotyczące ich nawyków związanych z braniem prysznica, praniem, wydajnością urządzeń. Dodatkowo użytkownicy pytani są o ich zainteresowanie ochroną środowiska.

WUC zestawia ze sobą zdanie poszczególnych użytkowników w kilku wymiarach: technologicznym (wydajność urządzeń), zużycia wody (ograniczenie go), ochrony środowiska (podejście jakie reprezentuje użytkownik do tego zagadnienia). Informacje jakie przekazuje użytkownik pozwalają na jasne określenie gdzie technologia i/lub zwyczaje użytkownika stoją w sprzeczności z jego podejściem do środowiska. Identyfikacja tych rozbieżności może pomóc użytkownikowi w określeniu istniejących sprzeczności i zmotywować go do zweryfikowania swoich przyzwyczajeń czy jakości stosowanych urządzeń. WUC dostarcza także informacji dotyczących tego jakie działania powinni podjąć poszczególni użytkownicy w celu zredukowania zużycia wody. W przeciwieństwie do DSS porady te kierowane są do konkretnych członków gospodarstwa domowego.